

(12) UK Patent Application (19) GB (11) 2 007 569 A

(21) Application No 7842985

(22) Date of filing 2 Nov 1978

(23) Claims filed 2 Nov 1978

(30) Priority data

(31) 46987/77

(32) 11 Nov 1977

(33) United Kingdom (GB)

(43) Application published

23 May 1979

(51) INT CL²

B21D 41/02//B21C 1/24

(52) Domestic classification

B3P 31B 34

B3A 134

B3J 15

(56) Documents cited

GB 11166901

GB 408453

(58) Field of search

B3P

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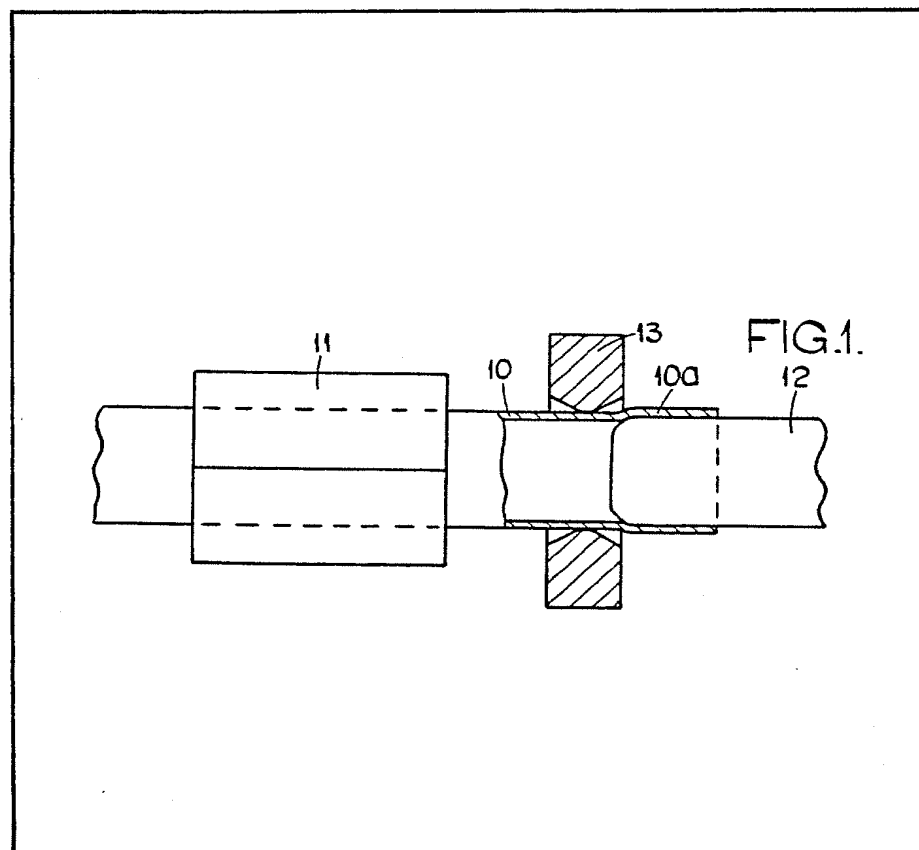
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(54) Method of Forming a Counterbore in the End of a Tube

(57) The tube of circular or non-circular cross-section is first arranged on one side of a die (13 or 19 or 24), a mandrel (12 or 18 or 23) being disposed on the opposite side of the die, relative movement then being effected between the tube on the one hand and the die and the mandrel on

the other hand to cause the end of the tube to enter said die and engage the mandrel which is larger in cross-section than the tube end so that the latter will be bulged by the mandrel, whereafter relative movement is effected between the die and the mandrel to move the die towards and over the mandrel and thereby draw the bulged end portion of the tube on to the mandrel.



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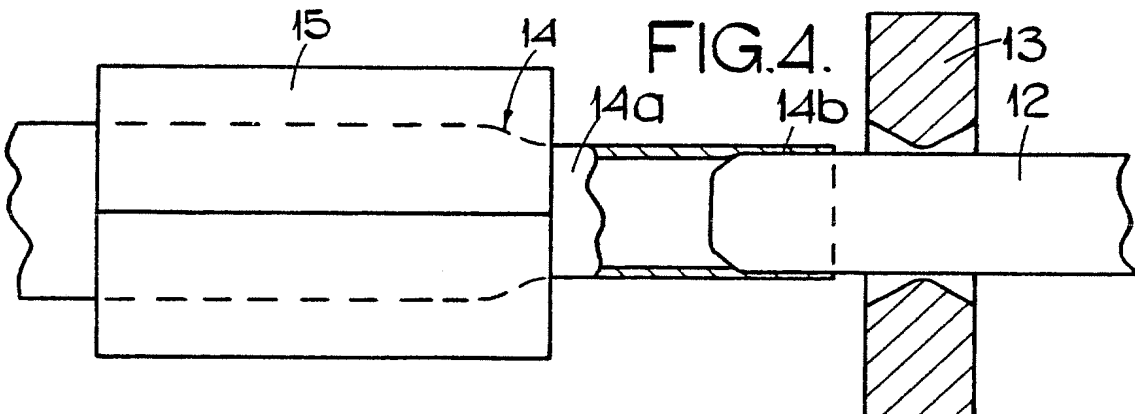
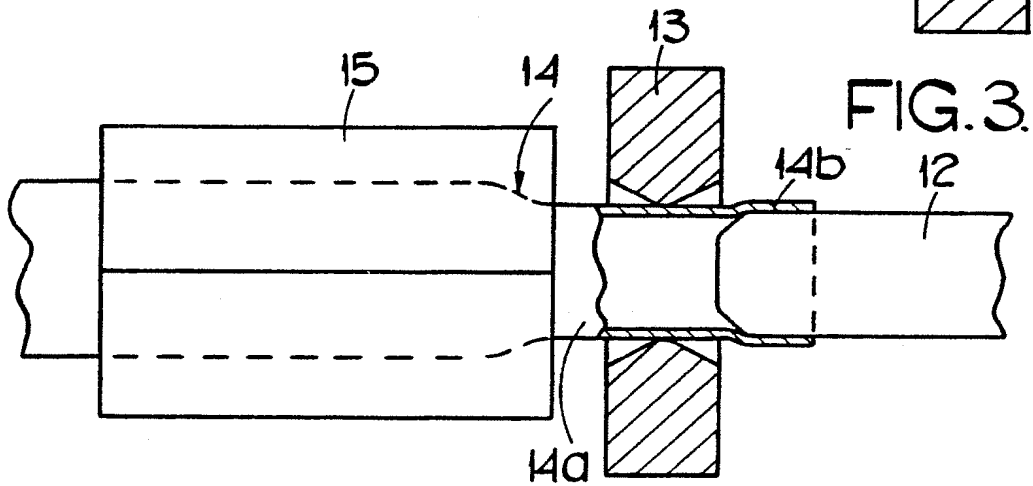
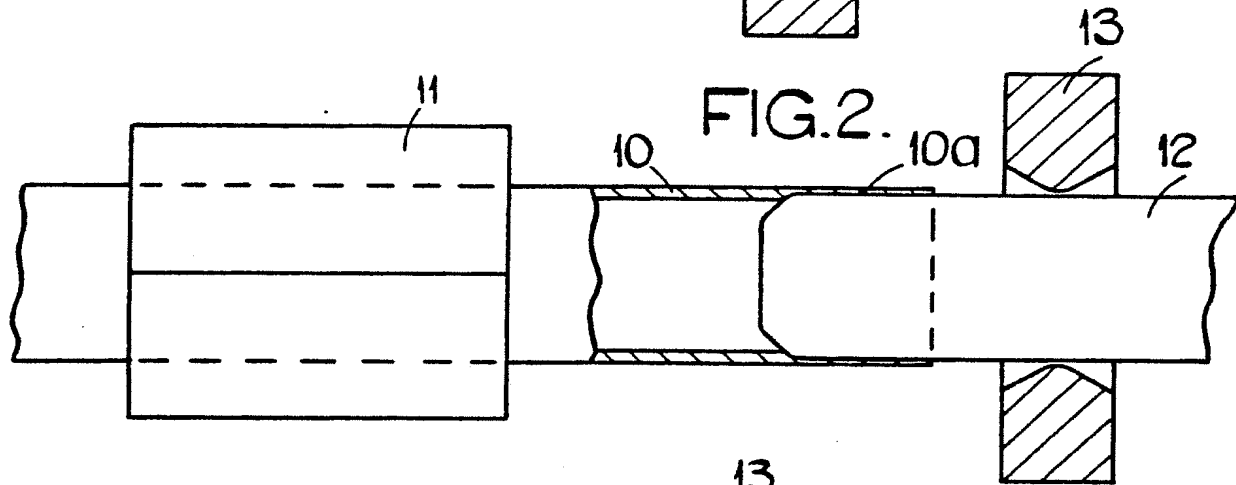
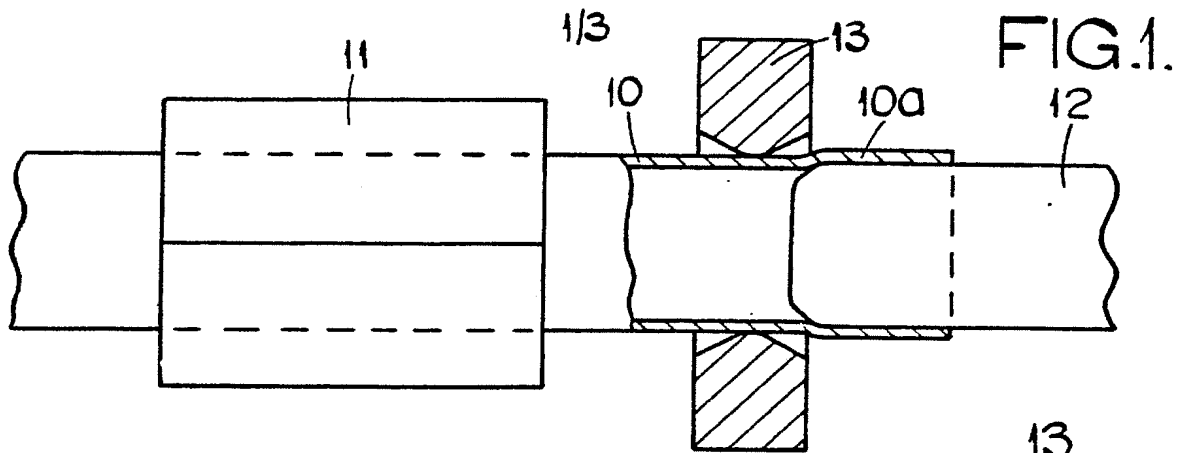


FIG.5.

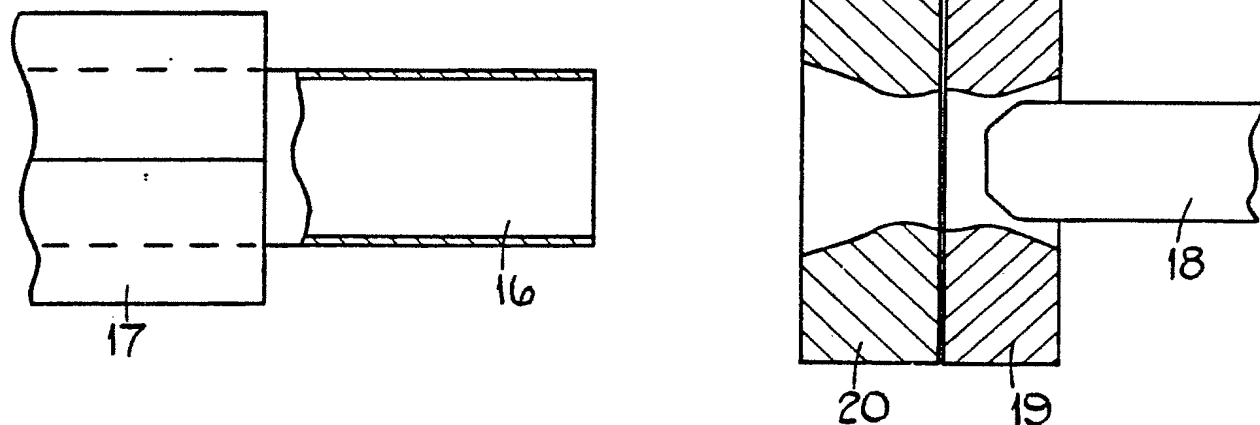


FIG.6.

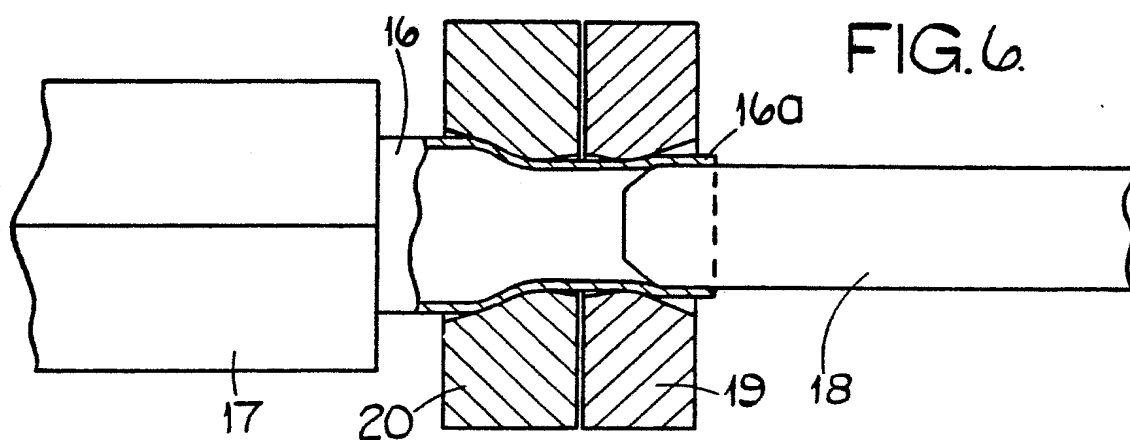
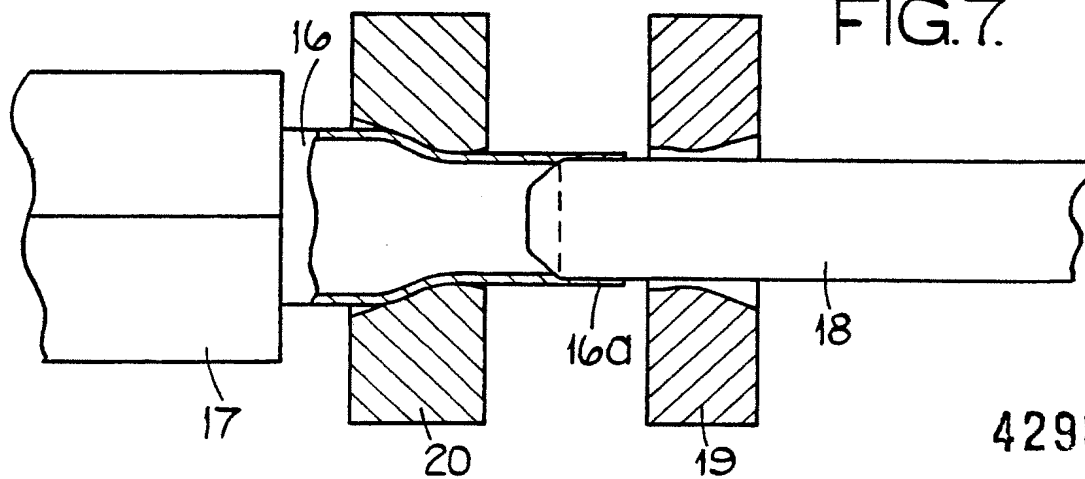


FIG.7.



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FIG.8.

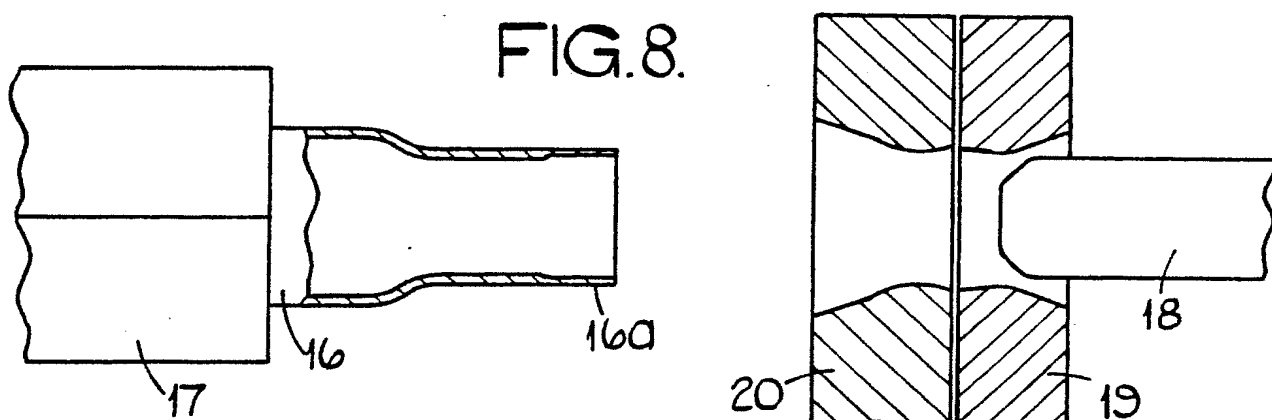


FIG.9.

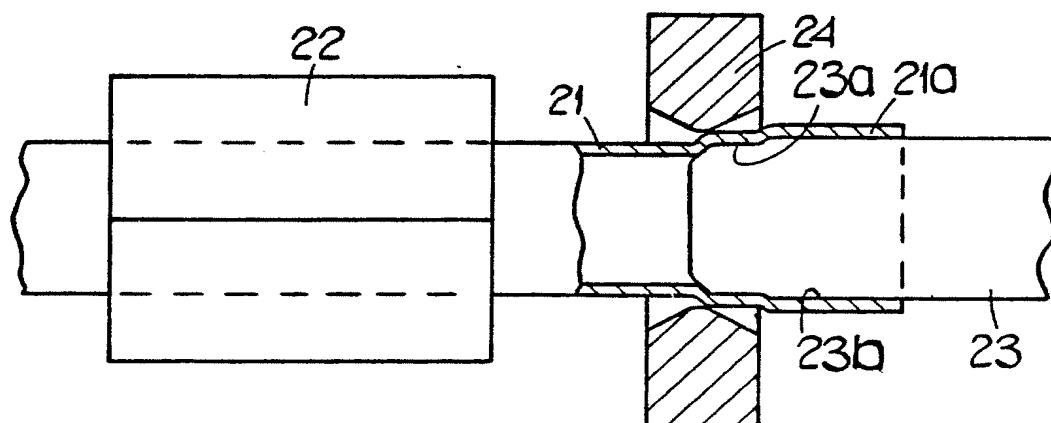
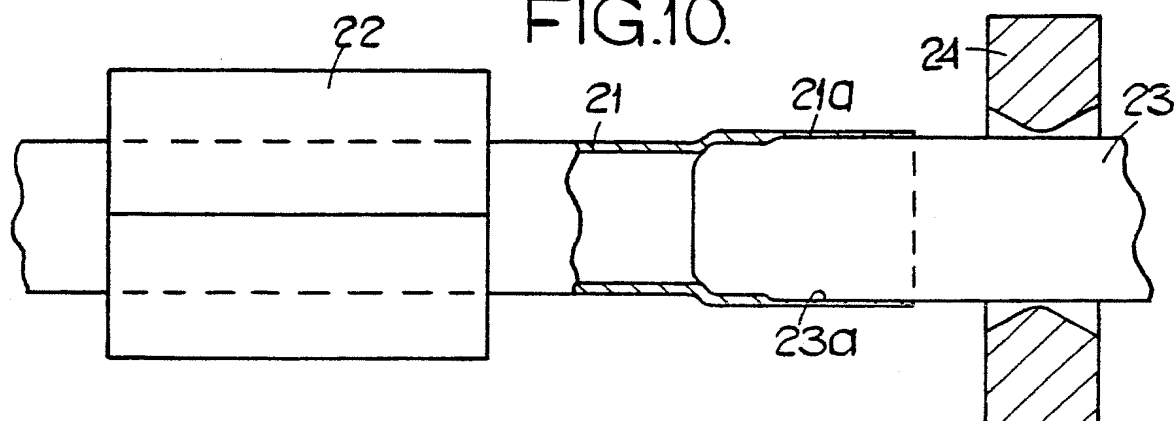


FIG.10.



SPECIFICATION

A Method of Forming a Counterbore in the end of a Tube

This invention relates to a method forming a counterbore in the end of a tube. Such a counterbore may for example be used to locate a bearing for a steering column, the tube forming part of the column assembly, although it is to be understood that the invention is not necessarily restricted to such an application. Where a bearing is to be housed however it is important to ensure that the counterbore is accurately formed and in one previously known method a machining operation is used. This however is expensive and one object of the present invention is to provide an improved, less expensive, method which will nevertheless produce an accurately formed counterbore.

In accordance with the invention there is provided a method of forming a counterbore in the end of a tube wherein said tube end is caused to enter a die from one axial end thereof and then to be located on the end of a mandrel which projects towards or into said die from the other axial end thereof, said mandrel having the effect of bulging the tube end whereafter relative movement is effected between the die and the mandrel so that the die moves towards and over the mandrel and over that portion of the tube end positioned on the mandrel to draw said portion on to the mandrel and form the desired counterbore.

The tube may be of generally constant external cross-sectional configuration throughout its length or it may be preformed so that the end which is to be formed with the counterbore as aforesaid is of reduced or increased external cross-section.

Alternatively, a further die may be provided which will have the effect of reducing said tube end in the same sequence of operation used to form said counterbore. In this case, said further or reducing die is initially disposed adjacent to said first-mentioned or drawing die and the tube end is caused to enter first said reducing die, then said drawing die and is then located on the mandrel end. Reduction of the tube end by the reducing die and bulging by the mandrel are thus effected and afterwards the drawing die is passed over that portion of the tube end and located on the mandrel (i.e. the bulged portion) to form the desired counterbore. The reduced and counter-bored tube end is then withdrawn and the two dies are brought together again for the next cycle of operations.

The invention will now be more particularly described with reference to the accompanying drawings wherein:

Figures 1 and 2 show two successive stages in carrying out one example of a method in accordance with the invention, the method being here applied to a tube of circular cross-section and having a generally constant external diameter throughout its length.

Figures 3 and 4 show two successive stages in

carrying out a method similar to that illustrated by Figures 1 and 2 but now applied to a tube having a reduced end,

Figures 5—8 show four successive stages in carrying out a further example of a method in accordance with the invention, and

Figures 9 and 10 show two successive stages in carrying out yet a further example of a method in accordance with the invention.

Referring firstly to Figures 1 and 2 a tube of circular cross-section in one end of which a counterbore is to be formed is indicated by reference numeral 10, the tube being held by grips 11. There is also provided a mandrel 12 of generally cylindrical form and having an outside diameter which is larger than the initial internal diameter of said tube 10. In addition there is provided a die 13. Initially the mandrel 12 and the die 13 are moved together towards the tube 10 which is held in a stationary position by the grips 11 so that said die 13 passes over the end 10a of the tube 10 and the mandrel 12 enters said end 10a. The die opening is sufficiently large as to permit the die to pass over said end 10a of the tube 10 before the end of the mandrel 12 enters the tube end. This condition is indicated in Figure 1 and it will be seen that said end 10a of the tube has therein been bulged or expanded by the mandrel to a predetermined depth and internal diameter which depend respectively on the depth of penetration of said mandrel 12 and the external diameter thereof. The next stage in the operation is indicated in Figure 2 and here the mandrel 12, as well as the tube 10, is held in a stationary position, whilst the die 13 is moved independently of the mandrel away from the tube 10 so that it passes over the previously bulged end 10a of said tube. Said bulged end 10a will thus be drawn by said die 13 over the end of the mandrel 12 to leave the tube 10 with a constant external diameter and a counterbore formed in said end 10a. As previously mentioned said counterbore may be used to receive and locate a bearing housing.

In the alternative arrangement shown in Figures 3 and 4 there is provided a mandrel 12 and a die 13 as before but in this case the tube 14 (which is held in grips 15) is preformed so that it has a reduced end as is generally indicated by reference numeral 14a. As is the case with the method illustrated in Figures 1 and 2 however the die 13 and mandrel 12 are initially advanced towards the stationary tube 14 so that the die 13 will pass over the end 14b of the tube before said end is bulged or expanded by the leading end of the mandrel 12. The mandrel is then held stationary whilst the die is withdrawn over said end 14b of the tube 14 as indicated in Figure 4 and finally the mandrel 12 itself is withdrawn to its original position relative to the die 13 prior to another similar cycle of operations on another tube. The tube 14 however with its preformed portion 14a will be provided with an end 14b having a counterbore as before.

Referring now to Figures 5—8 there is

illustrated therein an alternative method of forming a counterbore in the end of the tube whilst at the same time reducing the diameter of said end of the tube. The tube is indicated in

5 Figures 5—8 by reference numeral 16 and is of circular cross-section and initially of constant external and internal diameters and is held in grips 17. There is also provided a mandrel 18 together with a drawing die 19 and a reducing die 20. Initially, as shown in Figure 5, the drawing die 19 and the reducing die 20 are disposed adjacent to each other and the leading end of said mandrel 18 projects towards and into the aperture of the drawing die 19 from that axial end thereof 15 opposite to the axial end towards which said tube 16 projects. In the next stage of operation said mandrel 18 and the two dies 19 and 20 are advanced together towards the projecting end of the tube 16 so that firstly said reducing die 20 will reduce said projecting end of the tube 16, forming a neck thereon. The mandrel and dies are advanced sufficiently far to cause the leading end of said mandrel to enter into the previously reduced end 16a of the tube and said mandrel will 25 thus bulge or expand said end 16a. This stage is illustrated in Figure 6 and the next stage is illustrated in Figure 7 in which the die 20 and the mandrel 18 and also the tube 16 are all held stationary whilst the drawing die 19 is withdrawn 30 over the end 16a of the tube so as to draw the previously bulged portion onto the leading end of the mandrel 18.

Finally, as illustrated in Figure 8, the reducing die 20 is withdrawn over the end 16a of the tube 35 until it again lies adjacent to the drawing die 19 when the whole assembly of mandrel and dies will be ready to operate on another tube, said tube 16 thus being left with an end portion which is of reduced diameter as compared with the remainder of the tube and in which is provided an end 16a having a counterbore which is adapted for example to receive a bearing housing.

In the method illustrated in Figures 9 and 10, the tube to be formed with a counterbore is 45 indicated by reference numeral 21 and is held by grips 22. In this case however the mandrel 23 is formed with a leading portion 23a having an external diameter which is larger than the original internal diameter of said tube 21, followed by a still larger portion 23b. Also the drawing die 24 has an aperture which is larger than the original external diameter of said tube 21. In the first stage of operation, illustrated in Figure 9, the end 21a of the tube is pushed on to the mandrel so that said mandrel portion 23a expands said end 21a and continuing movement of the tube results in further expansion by the portion 23b of the mandrel. In the second stage of the operation, the drawing die 24 is drawn back over said expanded 50 end 21a to form a counterbore as before but in this case said counterbore will be formed in an expanded tube end.

In all of the above described methods the operations are carried out whilst the tube is in a cold condition and the tube itself may either be of the seamless kind or alternatively it may be seamed. In either case however the aforesaid counterbore will be very accurately formed as to provide a recess which can be held to very close tolerances (and which is therefore adapted to receive and locate for example a bearing housing) in spite of the fact that expensive machining operations are avoided. Furthermore, although in the above-described examples said counterbore 75 and the tube itself are each of circular cross-section, it is to be understood that the present invention can be applied to cases where the counterbore has a cross-sectional which is non-circular, for example, square or particular with flats. Also, the tube itself need not be of circular cross section. 80

Claims

1. A method of forming a counterbore in the end of a tube characterised in that said tube end is caused to enter a die (13 or 19 or 24) from one axial end thereof and then to be located on the end of a mandrel (12 or 18 or 22) which projects towards or into said die from the other axial end thereof, said mandrel having the effect of bulging 90 the tube end whereafter relative movement is effected between the die and the mandrel so that the die moves towards and over the mandrel and over that portion of the tube end positioned on the mandrel to draw said portion on to the mandrel and form the desired counterbore. 95

2. A method of forming a counterbore in the end of a tube as claimed in Claim 1, characterised in that said tube end is first treated so that it has a cross-sectional area which is different from the remainder of the tube. 100

3. A method of forming a counterbore in the end of a tube as claimed in Claim 2, characterised in that said tube end is first caused to enter another die (20) which is arranged to effect a reduction of the tube end before the latter is caused to enter said first-mentioned die. 105

4. A method of forming a counterbore in the end of a tube as claimed in Claim 2, characterised in that said tube end is first expanded by the leading end portion (23a) of the mandrel (23) before it is bulged by another portion (23b) of said mandrel. 110

5. A method forming a counterbore in the end of a tube as claimed in Claim 3, characterised in said other die (20) and said first-mentioned die (19) are initially disposed in an end-to-end relationship whilst said reduction of the tube end and the bulging thereof is effected, whereafter the first-mentioned die (19) is displaced away from said other die (20) and over the mandrel (18) to draw the bulged tube end portion on to the mandrel. 120

6. A method of forming a counterbore in the

end of a tube substantially as hereinbefore
described with reference to Figures 1 and 2 or

Figures 3 and 4, or Figures 5—8, or Figures 9 and
10 of the accompanying drawings.

Printed for Her Majesty's Stationery Office by the Courier Press, Leamington Spa, 1979. Published by the Patent Office,
25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.